21st Century Territorial Security
a sensor networking approach

A Larus Technologies & GE Fanuc Intelligent Platforms White Paper
November 2008

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21st Century Territorial Security

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Abstract

Territorial security deals with the prevention, detection, and response to unauthorized persons and/or goods from crossing a perimeter. It deals with large territories of strategic importance, such as international borders, transportation and critical infrastructure. Sensor networks are novel data routing and processing structures that enable data-centric applications, such as the continuous monitoring of an elderly person's health. In this white paper, we concentrate on the challenges presented in applying the concepts of sensor networking and data fusion to the problem of territorial security, and how we plan to resolve them. We first introduce the conventional techniques and their drawbacks, then briefly present our solution and the steps involved in its development.

Territorial Security

Preventing, detecting, and responding to unauthorized persons and/or goods crossing a perimeter is a security concern of individual, corporate, and international scope. State-of-the-art perimeter-security solutions use physical barriers, sensors (indoor motion, cameras, audio/vibration), and human personnel (a camera operator, entrance guard, and patrolling security guards). These procedures are effective in a limited scenario, where a few entrance points are constrained by well-delineated physical boundaries.

Territorial security, however, deals with large territories of strategic importance, such as international borders, transportation (airports, rail yards, public transit), and critical infrastructure (energy, water & agriculture, emergency services, etc.) [1]. When dealing with such a scope, a number of challenges present themselves. First, a linked security system of this size is inflexible and expensive to setup. Second, system operators frequently suffer from overload, stress, and inattention due to the substantial influx of data. Finally, it is increasingly important for territorial security systems to allow for the sharing of knowledge to authorized users and systems.

Larus Technologies and GE-Fanuc Intelligent Platforms propose a novel, real-time decision-support-system intended to provide overall territorial security for an area of strategic importance. The proposed system starts by sensing the environment.

Sensor Networks

Current perimeter-security systems demonstrate the effectiveness of fixed, wired sensor networks. A network of sensor nodes positioned along a perimeter collects disparate and diverse types of relevant data [2]. As examples of perimeter-security sensor suites: color and infrared cameras enable the detection and recognition of intruders; acoustic sensors sense activities near a barrier, such as digging; while sonar and radar provide the location of marine or air-based objects.

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Due to the problem size, territorial security must be more flexible from a deployment standpoint, than traditional perimeter security. In our proposed solution, sensor nodes themselves need not be stationary; in fact, they may reside on mobile platforms such as manned/unmanned ground/aerial vehicles. This sensor node mobility provides the requisite flexibility for large-area deployment and decreases initial setup costs.

To provide such mobility, Larus and GE Fanuc intend to equip stationary and mobile platforms with a sensor payload that includes video, acoustic data capture, radar, and a Global Positioning System (GPS). The system design is flexible, allowing the use of a variety of data sources. Bandwidth-intensive data, such as audio and video data, must be compressed and/or processed before transmission. Fortunately, GE Fanuc's video capture and compression solution enables the compression and transmission of these data streams over a wireless communication link. Also, Larus has recently demonstrated the extraction of relevant features on visual data streams.

Larus' state-of-the-art intelligent video analytics technology includes motion detection, object tracking, face/vehicle detection, and license plate recognition. For example, in Figure 1 (left), the system tracks movement of a foreground object, a person, crossing an operator-defined polygon denoting a fence. Moreover, Figure 1 (right) shows the tracking of a stopped object as well as an abandoned object. The detection capability is robust against compression artifacts, imperfect focusing, and certain changing environmental conditions (e.g. light wind, rain, lighting variability).

Figure 1. Detecting object intrusion (left), stopped, and abandoned objects (right).
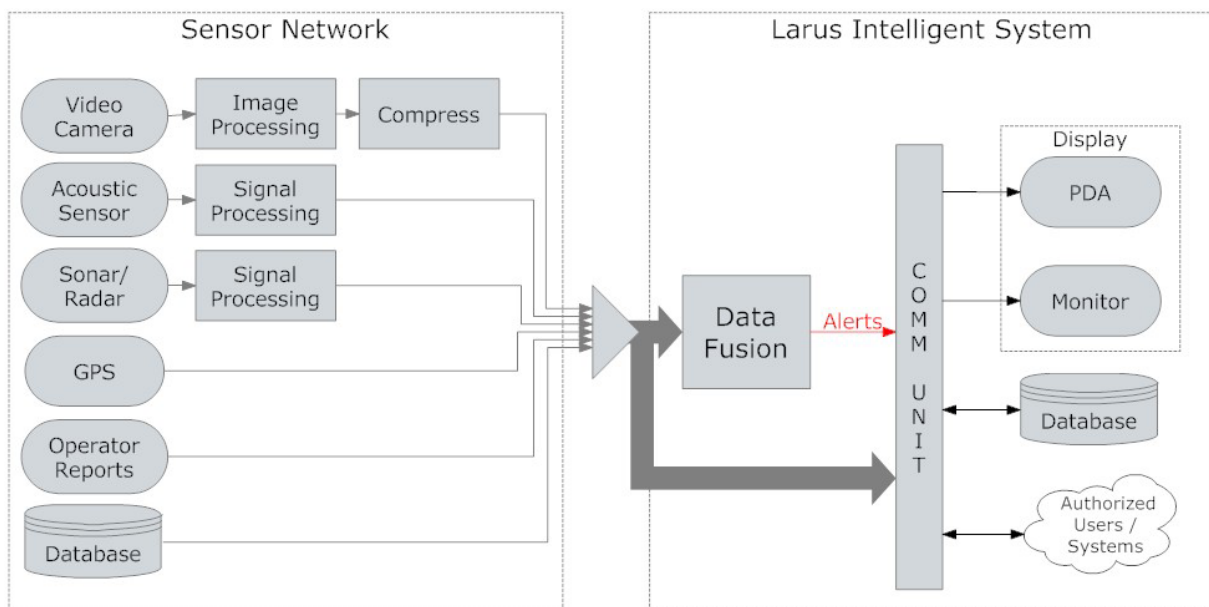
Data Fusion

In order to detect intrusions along a long perimeter, the tide of incoming data must be interpreted. This data is not limited to sensor readings; it can include databases, operator reports, and other sources of information (see Figure 2). The *Larus Intelligent System (LIS)* fuses these data streams in real-time, issuing alerts when anomalous behaviors are detected. Furthermore, the raw data is mined for patterns that represent information, with the set of patterns representing the knowledge attained by the system. This combination of data mining and fusion forms a decision-support system (DSS) and alleviates the strain on the operator by reducing the influx of information to a manageable level.

The operator's system display screen provides global and local informational views, aggregating the relevant system events and alerts. As demonstrated with GE-Fanuc's video integrated system, the display screen, processing, and storage module can even be ruggedized and located within moving vehicles [3]. This gives the operator and response team wide flexibility when planning appropriate counter measures.

The LIS uses well-developed, current technologies (XML and Semantic Web ontologies) to allow for future extensibility and to encourage interoperability with existing platforms. Information sharing and data fusion is a critical component in today's Homeland Security and MAJIIC initiatives [4][5]. Authorized users and systems are given secure access to each sensor's data stream, current and/or historical, as well as data fusion capabilities.


Figure 2. Data flow of proposed system.

The initial reference platform, shown in Figure 3, would consist of an unmanned ground vehicle (UGV) equipped with a data fusion payload that consists of a single-board computer (SBC), an integrated and deployable video compression system and an acoustic data capture system, running an intelligent data analytics software for the purpose of territorial security. The LIS runs a closed-loop decision-support system that takes in the data source inputs, extracts the required information from their raw data streams and, according to the user's decision, proceeds to perform a plan of action through effectuation of the environment. As the latter has now changed, the data consumption phase starts another run through the DSS loop.
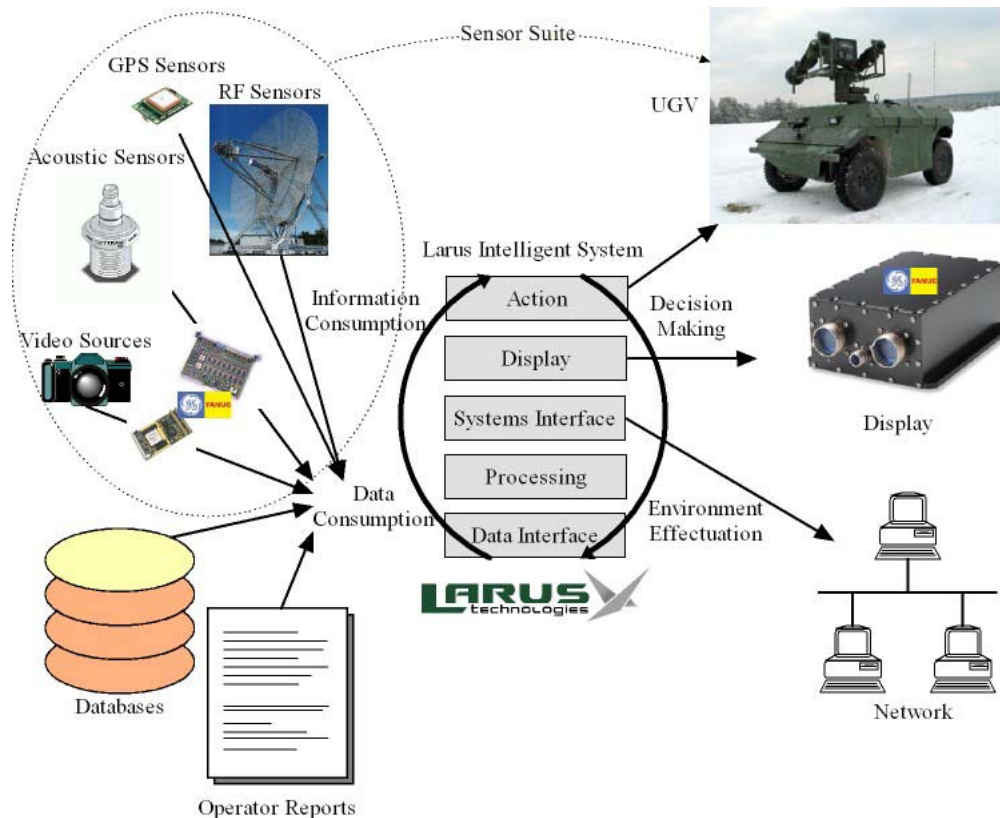
Figure 3. Initial reference platform.

Conclusions

Sensor networks and data fusion are poised to improve the state-of-the-art in territorial security systems. GE Fanuc Intelligent Platforms and Larus' product-line and expertise areas provide an ideal foundation to solve this task. Their intended solution offers data acquisition and deployment flexibility, eases operator overload, and offers interoperability/data sharing capabilities.

References

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About GE Fanuc Intelligent Platforms:

GE Fanuc Intelligent Platforms is a joint venture between General Electric (NYSE: GE) and FANUC LTD of Japan. They are headquartered in Charlottesville, Virginia with operating locations and regional offices throughout the United States and around the world. GE Fanuc, which is part of GE Enterprise Solutions, is a global provider of hardware and software used in automation and embedded computing. Their products are employed in virtually every industry, including manufacturing automation, defense, automotive, telecommunications, healthcare and aerospace.

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About Larus Technologies

Larus Technologies Corporation is a wholly-owned Canadian engineering and software development company, incorporated in August 1995. Larus is Ottawa-based with three core business areas, *Sensor Networking Solutions, Software Engineering Consulting,* primarily in the public security and defense sector, and *Professional Services Consulting*, working in partnership with Hays Recruitment Specialists. Larus was established by a group of software and hardware engineers to research and develop end-to-end real-time applications and data acquisition systems for the defence and aerospace industry. Larus also has capabilities in developing defence/security applications, intelligent systems and engineering simulations, through the development of advanced systems for multi-sensor data collection, aggregation, display, exploitation and fusion.

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